Docket: 2100/2

Claims:

1. An optical device comprising:

an NxN network, where N is an integer greater than or equal to 2, said network having N input ports for receiving optical input energy and N output ports for providing optical output energy, wherein the optical output energy at each of the output ports arises from interference among the optical input energy received at the input ports;

(N-1) feedback paths optically coupling (N-1) of the input ports of the NxN network to (N-1) of the output ports of the NxN network;

a first optical waveguide for receiving an input optical signal, said first optical waveguide being coupled to a remaining one of the input ports of the NxN network;

a second optical waveguide for the exit of an output optical signal, said second optical waveguide being coupled to a remaining one of the output ports of the NxN network; and

an active element selectively supplying gain or loss to optical energy in at least one of the feedback paths.

2. The optical device of claim 1 wherein said active element is an optical amplifier that includes a rare-earth active element and a pump source for pumping the rare-earth active element.

3. The optical device of claim 2 wherein said rare-earth active element is doped in said at least one feedback path.

4. The optical device of claim 3 wherein said at least one feedback path includes an optical waveguide and the rare-earth active element extends along substantially the entire length of the optical waveguide.

5. The optical device of claim 1 further comprising a second active element supplying gain or loss in the NxN network.

6. The optical device of claim 1 wherein said active element is configured to substantially compensate for resonant losses that arise in the second optical waveguide.

7. The optical device of claim 1 wherein each of said feedback paths and a portion of the NxN network comprises at least one ring resonator.

8. The optical device of claim 7 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a ring cascade.

9. The optical device of claim 7 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a series of coupled rings.

10. The optical device of claim 1 wherein said NxN network is a 2x2 network.

11. The optical device of claim 10 wherein said 2x2 network is a directional coupler.

12. The optical device of claim 10 wherein said 2x2 network is a Mach-Zehnder interferometer.

13. The optical device of claim 1 further comprising an all-pass filter located in at least one of the feedback paths.

14. The optical device of claim 2 wherein said optical amplifier is configured to substantially compensate for resonant losses that arise in at least one of the feedback paths.

15. An optical device comprising:

an NxN network, where N is an integer greater than or equal to 2, said network having N input ports for receiving optical input energy and N output ports for providing optical output energy, wherein the optical output energy at each of the output ports arises from interference among the optical input energy received at the input ports;

(N-1) feedback paths optically coupling (N-1) of the input ports of the NxN network to (N-1) of the output ports of the NxN network;

a first optical waveguide for receiving an input optical signal, said first optical waveguide being coupled to a remaining one of the input ports of the NxN network;

a second optical waveguide for the exit of an output optical signal, said second optical waveguide being coupled to a remaining one of the output ports of the NxN network; and

an active element selectively supplying gain or loss to optical energy in the NxN network.

16. The optical device of claim 15 wherein said active element is an optical amplifier that includes a rare-earth active element and a pump source for pumping the rare-earth active element.

17. The optical device of claim 16 wherein said rare-earth active element is doped in at least one waveguide located in the NxN network.

18. The optical device of claim 15 further comprising a second active element supplying gain or loss in at least one of the feedback paths.

19. The optical device of claim 15 wherein said active element is configured to at least substantially compensate for resonant losses that arise in the (N-1) feedback paths.

20. The optical device of claim 15 wherein each of said feedback paths and a portion of the NxN network comprises at least one ring resonator.

21. The optical device of claim 20 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a ring cascade.

22. The optical device of claim 20 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a series of coupled rings.

23. The optical device of claim 15 wherein said NxN network is a 2x2 network.

24. The optical device of claim 23 wherein said 2x2 network is a directional coupler.

25. The optical device of claim 23 wherein said 2x2 network is a Mach-Zehnder interferometer.

26. The optical device of claim 15 further comprising an all-pass filter located in at least one of the feedback paths.

27. A method of reducing the dispersion of an optical signal comprising the steps of:

directing the optical signal to an input waveguide of an optical device, said input waveguide being coupled to a first input port of an NxN network, where N is an integer greater than or equal to 2, said network having N input ports for receiving optical input energy and N output ports for providing optical output energy, wherein the optical output energy at each of the output ports arises from interference among the optical input energy received at the input ports, said optical device further including (N-1) feedback paths optically coupling (N-1) of the input ports of the NxN network to (N-1) of the output ports of the NxN

network, a remaining one of the output ports of the NxN network providing a dispersion compensated optical output signal; and

selectively supplying gain or loss to optical energy in at least one of the feedback paths to reduce to a selected value the dispersion of the dispersion compensated optical output signal.

28. The method of claim 27 wherein gain or loss is selectively supplied by an optical amplifier that includes a rare-earth active element and a pump source for pumping the rare-earth active element.

29. The method of claim 28 wherein said rare-earth active element is doped in said at least one feedback path.

30. The method of claim 29 wherein said at least one feedback path includes an optical waveguide and the rare-earth active element extends along substantially the entire length of the optical waveguide.

31. The method of claim 27 further comprising the step of supplying gain or loss in the NxN network.

32. The method of claim 27 wherein said gain at least substantially compensates for resonant losses that arise in said at least one feedback path.

33. The method of claim 27 wherein each of said feedback paths and a portion of the NxN network comprises at least one ring resonator.

34. The method of claim 33 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a ring cascade.

35. The method of claim 34 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a series of coupled rings.

36. The method of claim 27 wherein said NxN network is a 2x2 network.

37. The method of claim 36 wherein said 2x2 network is a directional coupler.

38. The method of claim 36 wherein said 2x2 network is a Mach-Zehnder interferometer.

39. The method of claim 27 further comprising an all-pass filter located in at least one of the feedback paths.

40. The method of claim 32 wherein said gain also substantially compensates for non-resonant losses that arise in the NxN network.

41. A method of reducing the dispersion of an optical signal comprising the steps of:

directing the optical signal to an input waveguide of an optical device, said input waveguide being coupled to a first input port of an NxN network, where N is an integer greater than or equal to 2, said network having N input ports for receiving optical input energy and N output ports for providing optical output energy, wherein the optical output energy at each of the output ports arises from interference among the optical input energy received at the input ports, said optical device further including (N-1) feedback paths optically coupling (N-1) of the input ports of the NxN network to (N-1) of the output ports of the NxN network, a remaining one of the output ports of the NxN network providing a dispersion compensated optical output signal; and

selectively supplying gain or loss to optical energy in said NxN network to reduce to a selected value the dispersion of the dispersion compensated optical output signal.

42. The method of claim 41 wherein gain or loss is selectively supplied by an optical amplifier that includes a rare-earth active element and a pump source for pumping the rare-earth active element.

43. The method of claim 42 wherein said rare-earth active element is doped in at least one waveguide located in said NxN network.

44. The method of claim 41 further comprising the step of supplying gain or loss in at least one of the feedback paths.

45. The method of claim 41 wherein said gain at least substantially compensates for resonant losses that arise in at least one of the feedback paths.

46. The method of claim 41 wherein each of said feedback paths and a portion of the NxN network comprises at least one ring resonator.

47. The method of claim 46 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a ring cascade.

48. The method of claim 46 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a series of coupled rings.

49. The method of claim 41 wherein said NxN network is a 2x2 network.

50. The method of claim 49 wherein said 2x2 network is a directional coupler.

51. The method of claim 49 wherein said 2x2 network is a Mach-Zehnder interferometer.

52. The method of claim 41 further comprising an all-pass filter located in at least one of the feedback paths.

53. The method of claim 45 wherein said gain also substantially compensates for non-resonant losses that arise in the NxN network.

54. A method of amplifying an optical signal comprising the steps of:

directing the optical signal to an input waveguide of an optical device, said input waveguide being coupled to a first input port of an NxN network, where N is an integer greater than or equal to 2, said network having N input ports for receiving optical input energy and N output ports for providing optical output energy, wherein the optical output energy at each of the output ports arises from interference among the optical input energy received at the input ports, said optical device further including (N-1) feedback paths optically coupling (N-1) of the input ports of the NxN network to (N-1) of the output ports of the NxN network, a remaining one of the output ports of the NxN network providing a optical output signal; and

selectively tuning a coupling coefficient between the first input port and said remaining one of the output ports to adjust to a selected value the gain or loss imparted to the optical output signal.

55. The method of claim 54 wherein each of said feedback paths and a portion of the NxN network comprises at least one ring resonator.

56. The method of claim 54 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a ring cascade.

57. The method of claim 55 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a series of coupled rings.

58. The method of claim 54 wherein said NxN network is a 2x2 network.

59. The method of claim 58 wherein said 2x2 network is a directional coupler.

60. The method of claim 58 wherein said 2x2 network is a Mach-Zehnder interferometer.

61. The method of claim 54 further comprising an all-pass filter located in at least one of the feedback paths.

62. A method of amplifying an optical signal comprising the steps of:

directing the optical signal to an input waveguide of an optical device, said input waveguide being coupled to a first input port of an NxN network, where N is an integer greater than or equal to 2, said network having N input ports for receiving optical input energy and N output ports for providing optical output energy, wherein the optical output energy at each of the output ports arises from interference among the optical input energy received at the input ports, said optical device further including (N-1) feedback paths optically coupling (N-1) of the input ports of the NxN network to (N-1) of the output ports of the NxN network, a remaining one of the output ports of the NxN network providing a optical output signal; and

selectively tuning a resonant wavelength in at least one of the feedback paths to adjust to a selected value the gain or loss imparted to the optical output signal.

63. The method of claim 62 wherein each of said feedback paths and a portion of the NxN network comprises at least one ring resonator.

64. The method of claim 62 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a ring cascade.

65. The method of claim 63 wherein each of said feedback paths and a portion of the NxN network comprises a plurality of ring resonators arranged as a series of coupled rings.

66. The method of claim 62 wherein said NxN network is a 2x2 network.

67. The method of claim 66 wherein said 2x2 network is a directional coupler.

68. The method of claim 66 wherein said 2x2 network is a Mach-Zehnder interferometer.

69. The method of claim 66 further comprising an all-pass filter located in at least one of the feedback paths.

70. The optical device of claim 1 wherein said active element is an optical amplifier that includes an electrically pumped semiconductor waveguide.

71. The optical device of claim 70 wherein said semiconductor waveguide is an InP-based waveguide.

72. The optical device of claim 15 wherein said active element is an optical amplifier that includes an electrically pumped semiconductor waveguide.

73. The optical device of claim 70 wherein said semiconductor waveguide is an InP-based waveguide.

74. The optical device of claim 1 wherein at least one of said feedback paths includes a cavity with a plurality of reflectors.

75. The optical device of claim 1 wherein said at least one feedback path includes a photonic band gap structure.

76. The optical device of claim 75 wherein the photonic band gap structure includes a plurality of a dielectric material for confining optical energy.

77. The optical device of claim 1 wherein said NxN network is a Gires-Tournois interferometer.